

Improving Environmental Indicators through Involvement of Experts, Stakeholders, and the Public¹

MICHELE MORRONE AND MATTHEW HAWLEY², School of Health Sciences, Ohio University, Athens, OH 45701

ABSTRACT. This research was motivated by the need to identify characteristics of environmental indicators that are meaningful to the public so that these indicators will convey conditions of environmental quality. Four focus groups were conducted to gather qualitative data about expert, stakeholder, and public knowledge and understanding of environmental indicators. The Lake Erie Quality Index (LEQI) was used as a model of environmental indicators and focus group participants offered reactions and interpretations of the LEQI. Results identify the level of the public's understanding of indicators, suggest characteristics that make indicators useful, and identify differences between how experts, stakeholders and the public interpret environmental indicators. All three groups agree on the importance of developing measurable environmental indicators that can present sound scientific information to the public.

OHIO J SCI 98 (3): 52-58, 1998

INTRODUCTION

Environmental indicators attempt to accurately describe environmental conditions and make available scientifically valid information on environmental trends. The strength of sound indicators of environmental quality lies in their ability to satisfy the need to present scientific information in an easily understood manner. This need is intensified as the public is entitled to, and demands, information about the environmental conditions of their land, air, and water.

Researchers at Florida State University (Emmert 1996) suggest that developing and using environmental indicators to describe actual environmental conditions is becoming increasingly popular. They note that, within the past five years, "there is now so much indicator work going on that the situation is almost chaotic." The Florida State researchers coordinated the State Environmental Goals and Indicators Project (SEGIP), and in the course of this effort they identified criteria that those developing indicators should employ. The criteria can serve as standards to select consistent and high quality indicators. Among the criteria that are not essential, but preferred, is that indicators should be "understandable." By understandable, SEGIP means:

The indicator should be simple and clear, and sufficiently non-technical to be comprehensible to the general public with a brief explanation. The indicator should lend itself to effective and appealing display and presentation.

Groups who use and research environmental indicators generally see indicators as communication and planning tools. Examples of the use of indicators as planning tools can be found in numerous state comparative risk, priority-setting, and strategic planning projects. Environmental indicators have been used by cities such as Jacksonville, FL (Jacksonville Community Council Inc. 1993) and Columbus, OH (Columbus Health Department

1997) to communicate environmental conditions and assess progress toward meeting goals. States such as Tennessee (TN DEC 1996) and Vermont (VT ANR 1996) update indicators annually so that the public can track trends in environmental quality.

In Ohio, the Ohio Comparative Risk Project (Morrone 1995) developed indicators to assess human health, ecosystem health and the quality of life in the state. The indicators were used in developing strategies to reduce environmental risk and in communicating environmental conditions to Ohio citizens. Environmental indicators are also critical components of the Ohio Water Resource Inventory which presents trends in water quality. Ohio EPA relies on biological indicators of water quality to assess the attainment status of Ohio's rivers and streams (Yoder and Rankin 1998).

Since indicators can be used for different purposes by decision makers, scientists and the public, it is critical that great care be taken in their development. One of the greatest challenges in indicator development is selecting indicators that meet the essential criteria of measurability, sound data quality, importance, and representativeness while being understandable to the public. As Lindsey and others (1997) explain, "the problem of interpretation, that of making data comprehensible while avoiding oversimplification, is one that has bedeviled planners for decades." The balance between having adequate information for indicator validity and keeping the indicators simple for public understanding is a difficult one to achieve.

When indicators are selected because they are scientifically-sound and understandable to the public, scientists may be laying planks on the bridge that has become known as the gap between scientific assessment of environmental issues and public perception of the same. This gap between science and perception has been discussed extensively (Foster and others 1993, Breyer 1995, Wildavsky 1995, Margolis 1996) and using indicators as a communication tool may be one approach to bridge it.

The gap between the public's and scientists' understanding of the environment was measured in the Ohio

¹Manuscript received 11 December 1997 and in revised form 14 July 1998 (#97-22).

²Matthew Hawley was a project assistant at the Ohio Environmental Protection Agency.

Comparative Risk Project. During the course of this statewide project, more than 30,000 citizens contributed their views on environmental conditions in the state. Forty-five potential environmental threats were ranked using a combination of scientific information and public perceptions. The severity of numerous environmental issues with current environmental indicators was found to be out of synch with public concerns. The Comparative Risk Project quantified a divergence between how Ohio citizens feel about some environmental issues and the actual state of the problem as suggested by indicators. Table 1 identifies some of the key differences between how Ohio citizens view several environmental conditions with what indicators tell us about these issues.

The differences between what the data say and how the public feels has frustrated both scientists and citizens. The reason that this anomaly exists may be based on a combination of factors, one of which may be that scientists are not making indicators accessible to the public. Availability is different from accessibility and just because the information is "out there" does not mean that the public can access it. Furthermore, accessibility includes understanding, and environmental scientists must be concerned with the citizens' interpretation of the data. Maybe the average citizen is confused by the indicators, or, perhaps indicators that are meaningful to the public are not being measured. The results of the comparative risk project underscore the fact that efforts to include the public in dialogue about environmental issues in general, and environmental indicators in particular, is crucial.

The focus group is a qualitative research tool that offers both a method for collecting qualitative information and a forum for detailed discussion about specific

issues (Krueger 1994). They can be used to "explore and understand the attitudes, beliefs, feelings, images, behaviors, and motivations" of the participants (Madriz 1998). Focus groups can assist environmental professionals in understanding perceptions of environmental hazards and in communicating risks to the public (Desvousges and Smith 1988). Environmental health professionals have used focus groups to improve the understandability of documents and approaches. The Healthy People 2000 Consortium successfully used focus groups to refine both the objectives for Healthy People 2010 and the presentation of these objectives to the public (Maiese and Fox 1998).

Focus groups are typically composed of 8-12 individuals and are facilitated by a professional facilitator with the use of a discussion guide. The researcher develops the guide to present questions that will stimulate discussion without leading it (Morse and Field 1995). A benefit of using focus groups rather than telephone polls in public opinion research, is their ability to provide in-depth qualitative information. In examining the utility of focus groups for understanding decision making about environmental hazards, Michaels (1993) concluded that "focus group interviews offer an effective means to include practitioners in applied research."

Focus groups have limitations, one of which is the potential for the group to be dominated by one person, resulting in other participants modifying their beliefs to fit in with the group. This problem of "groupthink" was noted by MacDougall and Baum (1997) who used a devil's advocate in a series of focus groups to keep the discussion on track. Another drawback to the focus group method is that, because of small sample size, researchers are unable to apply conclusions from focus

TABLE 1

Comparison of public views about environmental issues to environmental indicator information.

Issue	Public Views	Indicator
Disposal capacity	In a statewide random telephone poll, Ohioans identified a lack of solid waste disposal facilities as the most likely problem to occur among a list of 24 environmental issues.	Solid waste indicators suggest that solid waste disposal capacity is increasing in Ohio.
Water quality	The statewide telephone poll indicates that Ohioans consider declining water quality to be the second most likely problem to occur among a list of 24 issues.	Environmental indicators relative to this problem suggest that water quality in Ohio has been improving over the past 20 years.
Outdoor air quality	Results from numerous public outreach activities suggest that Ohio citizens view outdoor air quality as the greatest risk relative to many other environmental issues.	Indicators suggest the outdoor air quality in Ohio has improved greatly over the past 20 years.
Indoor air quality	Numerous public outreach activities suggest that Ohioans are relatively unconcerned about the risks from indoor air.	There are currently limited indicators relative to indoor air quality in Ohio, although national as well as Ohio experts evaluate the risks from this issue substantially higher than the public.

groups to the general population.

The objectives of this research are to use qualitative analysis to explore differences in interpretation of environmental indicators among stakeholders, experts, and the public. By continually exploring these differences, indicator developers will be better equipped to design indicators that address their need to communicate effectively with the public. For the purpose of this research, focus groups are an ideal mechanism for citizens to share ideas and opinions about environmental indicators. In particular, participants in focus groups about environmental indicators may partially answer the question: "what are the characteristics of environmental indicators that make these indicators understandable to the public."

This research was designed to answer the following questions:

1. What is the level of the public's understanding of Ohio environmental indicators, specifically those indicators that are used to measure attainment of environmental goals?
2. What are the characteristics of environmental indicators that contribute to making environmental indicators understandable to the public?
3. What are the differences between indicators that are understandable to the public and those that are evaluated as sound by environmental professionals?

MATERIALS AND METHODS

The Lake Erie Commission, as part of their strategic plan which was approved by the Governor, has used many people and hours to develop a Lake Erie Quality Index (LEQI) which organizes indicators of the quality of Lake Erie (Table 2). The LEQI breaks down the indicators of the lake into three separate groups: Environmental Quality Indicators, Economic Quality Indicators, and Recreation Quality Indicators. A total of eleven environmental indicators each with several metrics comprise the LEQI. For example, in the category of environmental quality, ambient water quality is one of the indicators. The metrics to quantify ambient water quality include toxic contaminants, contaminated sediments, water clarity and bacterial pollution. The LEQI offered a case study of environmental indicators and an opportunity to accomplish the goals of this research while providing valuable information to the Commission.

The Lake Erie Lakewide Management Plan (LaMP) was created by the Great Lakes Water Quality Agreement to develop and implement a complete plan of action to protect and restore the waters of Lake Erie. Environment Canada and US EPA, in partnership with agencies from the Province of Ontario and the states of Michigan, Ohio, Pennsylvania and New York, are working together in the Lake Erie LaMP process. Ohio has put state and federal funds into the process, and is seen as the lead state in the plan. The results of this qualitative research will also assist the LaMP when they begin to develop indicators of the entire lake.

TABLE 2

The proposed Lake Erie Quality Index.

Indicator Category	Environmental Indicators	Indicator Metrics
Environmental Quality	Ambient Water Quality	Toxic contaminants, contaminated sediments, water clarity, bacterial pollution, drinking water quality, oxygen depletion rate
	Water Pollution Loading	Point source loadings, rural nonpoint source loadings, urban nonpoint source loadings, waste site nonpoint source loadings, air pollution loadings
	Biological Integrity	Lake Erie Index of Biological Integrity
	Physical Integrity	Developed state of shoreline, wetlands, tributary spawning habitat, land use
Economic Quality	Tourism Quality	Tourism economic impacts
	Water Dependent Industrial Quality	Shipping, water dependent industry, cost advantage to state from using Lake Erie water, specialized agriculture
Recreation Quality	Fishing Quality	Angler success, angler satisfaction, public fishing access, fishing participation
	Boating Quality	Public access, marinas, safety, quality
	Swimming Quality	Public access, water quality, beach quality
	Coast Quality	Customer satisfaction with coastal activities

Selected Focus Groups

The goal of the focus group setting is to get as many ideas and as much information as possible. It is generally not the intent of focus group research to bring the participants to a common understanding of a particular problem or issue. Since no names are used in the results, the participants can talk freely of their opinions and beliefs. The participants are videotaped, audiotaped, and observed, but nothing they said is attributed to them or the group they represent. Maintaining anonymity is generally an important element of qualitative research. Researchers ensure focus group participants that their input will remain anonymous. This reduces participants' fears and allows them to be completely honest in their responses. One such fear is a "fear of offending" the organization that is gathering the data (Morse and Field 1995).

The participants in the focus groups were chosen from several different backgrounds and occupations (Table 3). Experts are those who have worked with Lake Erie and have credentials in limnology, fisheries biology, wildlife biology, wetlands, county tourism, economics, leisure studies, education, statistics, and land use. Stakeholders include recreational users of Lake Erie, commercial and sport fisheries interests, tourism officials, lakefront property owners and environmental

groups. The general public are citizens living in Northeast Ohio.

Cambridge Associates, a professional market research firm coordinated the focus groups using the standard focus group methodology that includes using a one way mirror, video and audio taping. The mirror allows researchers to observe the focus group without creating a validity problem with data collection. Morse and Field (1995, p 110) note that "the major difficulty interfering with validity in participant observation is the change in behavior in the setting when the observer is present." However, they also note that "the researcher must retain the freedom to enter and leave the setting as desired." The one-way mirror allows researchers to communicate with the facilitator through notes to ensure that the data is valid.

A professional facilitator led 3 focus groups with the use of a discussion guide developed by Ohio EPA staff. The fourth focus group, which was a combination of participants from the first three groups, was led by the lead researcher. Each focus group lasted two hours and participants were offered monetary incentives for their involvement.

Discussion Guide

The discussion guide for the focus groups was developed by staff at Ohio EPA working with the Lake Erie Office, the Office of Environmental Education, and the LaMP. The facilitator used the guide to structure the discussion and obtain several key data.

The guide began with a discussion of participants' ideas about environmental indicators in general. A definition of environmental indicators was presented and participants spent time discussing the use of indicators to measure environmental quality. Then, the LEQI was distributed and participants were asked to react to it. Several of the individual indicators were discussed at length, with the metrics and measurements examined in depth. Finally, participants were asked to rank indicators of Lake Erie quality.

RESULTS

Video and audio tapes of focus group sessions were reviewed at length to evaluate the level of public understanding of the LEQI, the characteristics that are important in indicators, and the differences among the three groups. All groups discussed the need to increase the public's understanding of environmental indicators and the importance of measurability in selecting high quality environmental indicators. In addition the groups discussed specific environmental indicators that are components of the LEQI, offering valuable insights to improving this tool. The following is a summary of reactions to specific LEQI components.

Ambient Water Quality: The public gauges water quality on the clarity of the water. Experts and stakeholders are more interested in specific chemical and biological measures.

Biological Integrity: The proposed metric for this indicator is the Lake Erie Index of Biological Integrity. When the groups examined this indicator, the proposal

TABLE 3

Breakdown of focus groups.

Group name	Composition
Experts (11 participants)	Parks and Recreation (1) Economist (1) Environmental Consultant (1) Biologist (2) Environmental Specialist (1) Refuge Manager (1) Sanitary Engineer Administrator (1) Environmental Planner (1) Engineer (1) Port Authority (1)
Stakeholders (9 participants)	Environmental Organization Members (4) Sportsmen/Birdwatching Organization Members (4) Swim Club Member (1)
Public (10 participants) Geographically-based	Beachwood (1) Cleveland (1) Lakewood (2) Maple Heights (1) Rocky River (1) Seven Hills (1) Solon (2) South Hills (1)
Mixed Group (12 participants) Selected from above groups	Experts (4) Stakeholders (4) Public (4)

faced severe criticism about its completeness. Members of the public group were unsure of some of the terminology, for example, one member did not know what an invertebrate animal is.

Physical Integrity: The indicator of physical integrity was looked at only by the public group. Many were confused about the meaning of physical integrity and its importance as an indicator. The discussion focused on the wetland measurement and the definition of wetlands and who benefits from converting lands back to their natural state.

Water Pollution Loading: The expert focus group was asked to give their opinions on this indicator of loadings. The discussion revolved around comments on the incompleteness and unreliability of the metrics and measurements. The problem of explaining loadings in a way the public could understand was discussed. The result of that conversation was that terms such as "combined sewer overflow," "infiltration," and "inflow" are important but very difficult to explain.

Fishing Quality: The comments arising from looking at the fishing quality indicator show the distrust of surveys and qualitative measurements in general. Many of the stakeholders believe that fishing quality should be based on the population of available fish as opposed to how individuals did on a fishing trip.

Boating Quality: The main points brought up by the stakeholder group on boating were centered on safety and the problem of defining a good boating experience and the variance from person to person. The question of whether boating quality safety is a determinant of good quality or bad quality is an interesting view.

Additional results are a combination of thematic analysis and content analysis of the tapes and observations of the focus groups in process. While reviewing the tapes and notes of the focus groups, common themes emerged and several important topics surfaced.

Using thematic analysis, common themes from the focus groups include:

1. The LEQI, as presented, was not clearly understandable to the public.
2. Indicators must be easily measurable.
3. Indicators must be unbiased.
4. The public is mostly interested in a few indicators that directly affect them.
5. Indicators should be scientific and easy to understand at the same time.

Using content analysis, differences among the groups include:

1. The public group was more influenced by mass media when looking at environmental issues, while the experts and stakeholders sought more detailed sources.
2. The public was more likely than experts and stakeholders to view water quality as a function of the color of the water.
3. The experts felt that most of the indicators were incomplete or vague.

4. The stakeholders believe that a narrative should go along with each of the indicators.

Responses to Research Questions

Discussion in the focus groups contributed to answering the three research questions. The actual responses quoted below relate to the conclusions of this research.

What is the level of the public's understanding of environmental indicators? The public does not understand much of the scientific terminology employed in the LEQI and the experts may overestimate the knowledge level of the public. Some quotes from which to draw this conclusion include:

1. "This isn't something we poor peasants could even hope to begin to understand what the scientists are talking about." (public)
2. "A lot of this stuff is not going to mean anything to anybody unless they know someone in the scientific community. It all has to be out there so it can be validated. Then there's got to be some way for the layperson to tell whether or not there's movement in one direction or the other. That will be the challenge" (public)
3. "When dealing with the general public, you have to minimize the number of indicators that you have . . . you need an index that identifies progress." (expert)
4. "We don't want to underestimate the public. We're talking about an entire generation of Americans now that take these environmental issues much more seriously than the generation before." (expert)
5. "I have trouble really finding out what they are trying to say." (public)
6. "Tell us what's what and why. Show us how it is affecting us. We're laymen." (public)

What are the characteristics that make indicators useful? Indicators should be relevant to the audience and show change by presenting trends if possible. In addition, as some of the quotes below suggest, they should be concise and visual.

1. "Something that is sensitive to undesirable environmental changes. And something that you can continue to monitor in the future. And something that you have a good way of monitoring." (expert)
2. "To indicate water is healthy I'm thinking of relating it to human health because that really matters in terms of drinkable, swimmable, and fishable. Safe drinking water, you can eat all the fish you catch, and it's safe for swimming." (stakeholder)
3. "Must have indicators the general public can understand to get the public to make changes." (expert)
4. "Something that has research on it from the past." (expert)

5. "An indicator is which way it's going. And that's going to take time. Is the level of contaminant increasing or decreasing?" (public)
6. "People will look at pictures. If they could develop an icon system that is well defined, people could relate to that. We (stakeholders) would want more statistics." (stakeholder)
7. "The same way they do the pollen count. We're used to seeing that. Most people have someone in their family they watch for." (public)
8. "We don't know enough. Ten years from now, we may find something is important that we don't even know about. My suggestion is bar charts showing last year versus this year." (stakeholder)
9. "Measuring the rate at which oxygen is consumed is a wonderful thing, but it's empty and meaningless to most of us." (public)
10. "This indicator should indicate change so that the agency knows whether what they are doing is worthwhile or a failure and where they ought to make changes." (expert)

What are the differences in understanding among the three groups? Experts and stakeholders are more likely than the public to be concerned with pollution loadings and ambient quality of the water. The public appears to be more concerned with how the water looks and smells. Experts and stakeholders are also interested in indicators that depict the ecosystem quality, whereas the public group seemed more interested in quality of life and human health indicators. For example,

1. "The lake is not the lake of the 60s, 70s, or even 80s, the water quality is continuing to improve and that's what we're seeing with our bacterial tests." (expert)
2. "It's been a good five or six years since I went in the lake. I'm concerned about bacteria levels and mercury and I'm really not sure what else is in there." (public)
3. "I would divide [the condition of the Lake] into two parts really, the open water is much clearer than it used to be but clearer doesn't mean clean. You can't measure very much out in the open waters. Near shore you definitely can gauge pollution. After rain for two or three days there is a high bacterial count." (stakeholder)
4. "What about indigenous aquatic and nonaquatic plant life?" (stakeholder)
5. "What is an invertebrate animal?" (public)

DISCUSSION

The first question that this research was designed to answer was, "what is the level of the public's understanding of Ohio environmental indicators?" In terms of

assessing the level of public understanding of environmental indicators, the results suggest some important limitations. In general, the public group was somewhat overwhelmed by the LEQI and frustrated by its complexity. If people do not understand what is being measured (for example, invertebrate animals) then the indicator is meaningless and does not communicate an environmental condition.

Although the experts felt that indicators should be responsive to the level of public understanding, they appeared to overestimate the knowledge of the public. Some of the discussion among the experts suggests that the experts may view awareness and knowledge as synonymous. Some evidence suggests that the experts consider stakeholders to be the public and the discussions in the focus group clearly indicate that stakeholders are more knowledgeable than the public.

The characteristics of indicators that contribute to public understanding include relevance, simplicity, and history. One participant in the public group suggested that "the public really doesn't become involved until they are directly affected by the environmental issue." Stakeholders appear to have a more sophisticated level of knowledge about environmental conditions than the public and they want indicators that are based on science. Members of the public appear to be more interested in indicators that present information directly related to their daily lives and are presented in a rather simplistic manner. This suggests that, in summarizing data into environmental indicators, experts are extremely challenged to meet the needs of both stakeholders and the public, while keeping their professional integrity intact. The indicators most successful at communicating environmental conditions are relevant and simple, while having enough scientific data to make them reliable. The most relevant and simplistic indicators in the LEQI are those related to quality of life issues such as recreation and the economy.

The impact of presenting historical trends as a component of environmental indicators was mentioned several times by all three groups. In the stakeholder and public focus groups, historical information greatly enhanced understanding of indicator meaning. The historical level of the indicator 10, 20, or 30 years ago is necessary to find the direction and rate of the trend. Unfortunately, measuring environmental quality is a relatively new endeavor. Ohio EPA celebrated its 25th anniversary in 1998 and the most extensive air quality trend data has been collected for only 20 years. Other Ohio EPA programs, such as the toxic release inventory, are less than 10 years old and the measurement protocol changes from year to year, making it difficult to present trends.

Differences between the experts, stakeholders, and the general public emerged when the groups were asked to rank the indicators by how well they felt the indicators evaluated the condition of Lake Erie. The experts and the stakeholders were unwilling to rank the indicators, explaining that not enough information was available and there were too many questions unanswered in relation to the indicators. The members of the public focus

group quickly ranked the indicators without raising additional questions. This exercise suggested that the public voted regardless of whether they clearly understood the issue. This is important for environmental indicators development because, there may only be one chance to communicate with the public about environmental conditions. Therefore, extreme care should be taken to develop and present indicators that explain environmental conditions in the most efficient and effective way.

The understanding gained from these sessions has provided several different points of view and ideas that would have been very difficult to come up with otherwise. By using outreach tools such as focus groups, in-depth information can be gathered during indicator development. Although the data are qualitative and can not be generalized beyond the sample, the results have a richness that a public opinion poll would not.

LITERATURE CITED

- Breyer S. 1995. Breaking the Vicious Circle: Toward Effective Risk Regulation. Cambridge, MA: Harvard Univ Pr. 127 p.
- Columbus Health Department. 1997. 1997 Environmental Snapshot. Columbus, OH: Columbus Health Department. 50 p.
- Desvousges WH, Smith VK. 1988. Focus Groups and Risk Communication: The Science of Listening to Data. Risk Analysis 8:479-84.
- Emmert NO, editor. 1996. State Indicators of National Scope. Tallahassee (FL): Florida Center for Public Management. 177 p.
- Foster KR, Bernstein DE, Huber PW. 1993. Phantom Risk: Scientific Inference and the Law. Cambridge (MA): MIT Press. 457 p.
- Jacksonville Community Council, Inc. 1993. Life in Jacksonville: Quality Indicators for Progress. Jacksonville (FL): Jacksonville Community Council, Inc. 23 p.
- Krueger RA. 1994. Focus Groups: A Practical Guide for Applied Research, 2nd ed. Thousand Oaks (CA): Sage. 197 p.
- Lindsey G, Wittman J, Rummel M. 1997. Using Indices in Environmental Planning: Evaluating Policies for Wellfield Protection. J of Environ Plan Manag 40:685-705.
- MacDougall C, Baum F. 1997. The Devil's Advocate: A Strategy to Avoid Groupthink and Stimulate Discussion in Focus Groups. Qual Health Research 7:532-41.
- Madriz, EI. 1998. Using Focus Groups with Lower Socioeconomic Status Latina Women. Qual Inq 4:114-29.
- Maiese DR, Fox CE. 1998. Laying the Foundations for Healthy People 2010. Public Health Rpts 113:92-8.
- Margolis H. 1996. Dealing With Risk: Why the Public and the Experts Disagree on Environmental Issues. Chicago: Univ Chicago Pr. 227 p.
- Michaels S. 1993. Weighing Science and Politics in Local Decision Making About Hazards. Knowl Policy 6:3-23.
- Morrone M. 1995. State of the Environment Report. Columbus (OH): Ohio Environmental Protection Agency. 508 p.
- Morse JM, Field PA. 1995. Qualitative Research Methods for Health Professionals, 2nd ed. Thousand Oaks (CA): Sage. 254 p.
- TN DEC. 1996. Tennessee's Environment: 25 Years of Progress. Nashville: Tennessee Dept of Environ and Cons. 15 p.
- VT ANR. 1996. Environment. 1996: An Assessment of the Quality of Vermont's Environment. Waterbury (VT): Vermont Agency of Natural Resources. 19 p.
- Wildavsky A. 1995. But is it True? A Citizen's Guide to Health and Safety Issues. Cambridge (MA): Harvard Univ Pr. 574 p.
- Yoder CO, Rankin ET. 1998. The Role of Biological Indicators in a State Water Quality Management Process. Environ Monitor Assess 51:61-88.

The 1997 Paper of the Year Award

was presented at the Annual Meeting of the OAS
at
Miami University
Middletown Campus

on
5 April 1998
to:

James E. Evans and D. Erich Seamon

Department of Geology
Bowling Green State University
Bowling Green, OH

For their paper:

"A GIS Model to Calculate Sediment Yields from a Small Rural Watershed,
Old Woman Creek, Erie and Huron Counties, Ohio"

The Ohio Journal of Science 97(3):44-52